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ABSTRACT

This experiment in using computer-assisted curriculum planning in two British secondary schools tested the practicability of using computers not only in the annual compilation of school timetables but, more radically, in the characterization of constraints that "knock-on" from one year's timetable to the next. The Oxford School Timetabling System was used. Delay and unanticipated expense resulted in both schools from lack of immediate computer access since errors had to be corrected by phone or mail. The aims of the preliminary project were met in the Hengrove School but initial outcomes were disappointing at the Wells Blue School. In the Hengrove School about 85 percent of original specifications were met and the timetable had been completed by the insertion of a further 7.7 percent of items in a slightly degenerated form by reducing the number of sets provided without alteration of the curriculum, and the insertion of 4.6 percent of items with some structural variation. While such use of computers is still in the preliminary stages, researchers believed the experiment made some small steps forward. The development of entity pooling techniques is a future priority, as is the ability of schools to make their own informed choices between alternative strategies for "inching up" in the final compilation stages. (Author/JM)

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THE USE OF COMPUTER ASSISTANCE IN CURRICULUM PLANNING.

A Report of the Curriculum and Timetable Strategies
Preliminary Research Project, 1976-1978

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August 1978

This report is presented in this format as the preliminary report of a Teachers' Research Group on Curriculum Planning 1978-1979, which will be continuing with the Project.

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BACKGROUND

The Curriculum and Timetable Strategies Preliminary Research Project, funded by small grants totalling £1,000 from Avon and Somerset LEAs and from the University of Bristol School of Education, was carried through in two schools (Hengrove School, Avon and The Blue School, Wells, Somerset) during 1976-77. It arose from the common interest of the participants in the practicability of using computers to assist curriculum planners not only in the annual compilation of school timetables but, more radically, in the characterisation of constraints which "knock-on" from one year's timetable to the next. If the mechanisms by which these constraints are generated could in turn be understood and subjected to deliberate planning, then perhaps the timetable tail would be less able to wag the curriculum dog - even, or especially, in the context of falling rolls and of discussions of rationalisation of educational provision for the 16-19 age group.

An initial literature search was not encouraging. Transatlantic experience relates mainly to the problems of allocating students (or pupils!) to courses whose duration does not exceed that of one timetable cycle; it seems that little or no importance is in practice attached to the continuity of teacher/class relationships from one year to the next in North American High Schools operating credit systems,(1) although satisfactory completion of a particular credit is often made a precondition for entry to the next in 'linear' subjects such as mathematics. In this country it appears that the only remotely satisfactory systems in use on any significant scale prior to 1976, were systems (NORDATA and SPL) which were essentially heuristic simulations of 'best practice' in secondary schools. This emphasised the wide range of choice made available to pupils by providing highly intricate 'option blocks' of dissimilar subjects of study in their upper schools (i.e. pupils aged 14+ and upwards). The 'balance' of each pupils' curriculum in these later secondary school years has been seen by schools using this strategy, as an outcome of individual guidance processes. The timetable was seen as a potential impediment to the achievement of the ideal curriculum for each pupil. More recently however the question has been raised (Department of Education and Science, 1977, paras 2.6-2.23) as to whether pupils have 'too much choice'; schools are increasingly seeing the possibility of constructing patterns of options which ensure 'balance' for all pupils, at least insofar as this can be achieved by the inclusion of 'core' subjects in each child's programme.

It was, by contrast, an assumption made in setting up the present research that the strategy which we have come to call 'heterogeneous option blocking', might be a prime generator of 'knock-on' constraints, especially in schools where large numbers of lower school pupils (aged 11+ to 14+) were simultaneously taught whenever possible in homogeneous subject blocks (e.g. "Art, design and hand crafts", "humanities", "science" etc.) in order to promote a team approach to teaching and/or to curriculum development. For this latter purpose the increasingly popular 'faculty' timetabling approach was evidently more

(1) In recent discussion with a small number of Canadian and American School Administrators it was however suggested that year-to-year continuity of teacher-class relationships in UK schools was, in their view, one of the strengths of the system this side of the Atlantic.

appropriate[2] - but this too was widely believed to present practical difficulties for adoption by schools, especially where they were not experiencing rising rolls (or rapid staff turnover) during the period of implementation.

Would a 'hybrid' of these two approaches be better or worse than its parents - and, some might ask, would it be sterile? It was at this point that three important additions to the scanty literature on the subject appeared, almost simultaneously. John Brookes, of the School Timetabling Applications Group (the UK promoters of the NORDATA system), writing in an Open University reader (Brookes, 1975) gave an elegantly condensed expression of one of the usually unwritten features of timetabling when he wrote that 'The principle of compatibility is as follows: "subsets of a universal set of resources should be disjoint"', and followed 'this rather abstract example' with helpful examples (ibid. pp. 250-255). Regard this 'principle' as a 'law', or for 'should' substitute 'must', and one of the results, we observed, is consistent blocking as advocated by Hanson. Just where the boundaries between the blocks should be located remains as a problem, especially to those who, whether or not they have read Bernstein on the classification and framing of educational knowledge, see progress in curriculum development in terms of weakened inter-subject boundaries; we would only point out in passing that boundaries between subjects within blocks, which may be the more significant boundaries, are potentially weakened by consistent blocking and that advocates of integrated curricula might therefore find many commendable features in a school organisation which featured a small number of large blocks.[3]

The second addition to the literature at this time was the report by Lawrie and Veitch (1975) on their experience, at Strathclyde University, in attempting to develop a computer program capable of handling the secondary school 'layouts' which had been developed in Scotland.[4] Although Lawrie and Veitch's computer work was discontinued, they were able to point clearly to the potential of the computer as a planning tool rather than as a mere solver of a complex timetabling problem, given the existence of a solvable 'brief' from the curriculum planners. Indeed Lawrie's approach was intended to assist heads who thought in terms of broad categories (year groups, departments etc.)

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(2) In this context the practice of Faculty timetabling practice at the Castle School, Thornbury, Avon had been noted with particular interest (see also J.A. Johnson:(1973) and A.H.G. Spencer (1975)), as had the contribution of J.W. Hanson (1972) under the title "Consistent Blocking", which we prefer to "Faculty timetabling".

(3) Indeed this line of argument might be extended significantly further by regarding 'Schools within Schools' bringing curricular and pastoral functions together as at Countesthorpe, as the blocks from which a 'consistently blocked' school can be built (see J. Watts (1977) chs. 3 & 4).

(4) The concept of a 'layout' was first discussed by C.F. Lewis (1961). It has been linked by Lawrie and Veitch with methods of manual timetabling developed by C.H. Gordon at Moray House College of Education, which are further discussed by D.M. McIntosh and C.H. Gordon (1970). See also Lawrie and Veitch (1975).

to evaluate the feasibility of a timetablers' brief before making a fully detailed specification which might jeopardise the production of a usable timetable by overloading the brief with specified preassignments of entities (i.e. class/teacher/room/combination). In this respect Lawrie's approach probably offered the closest simulation yet of 'best practice' in the precompilation or curriculum planning stage. The book also drew our attention to the alternative, and potentially rigorous, approach to timetabling embodied in the work of Dempster et al (1975) who were the authors of our third addition to the literature at this time, a technical history of computer timetabling for schools.

The relatively brief reference in this latter paper to the Oxford system, of which Dempster himself had been the prime mover, suggested that it offered advantages at the curriculum planning stage over both the Strathclyde system (which could not always pinpoint the source of infeasibilities in a curriculum plan where this was due to overspecification of requirements) and over the already operational NORDATA and SPL systems. Considerable emphasis had been placed by Brookes (1976) on the advance made in providing an 'interactive' rather than a 'one-shot' approach requiring a complete and detailed specification of data from the outset, but it appeared that this was achieved by undertaking a series of partial compilations rather than by prior identification of necessary and sufficient conditions for a timetable to exist[5].

By contrast there were great attractions, for our purpose of developing a management tool for use in curriculum planning, of a system which claimed:

(i) to be potentially rigorous rather than heuristic.

(ii) to be able to proceed by substitution (or "interchange") of entities in an existing timetable rather than by starting from a blank sheet and thus to be capable of handling late amendments to briefs consequent upon such inponderable factors as staff changes and exam results.

(iii) to be of the same 'generation' of approaches as the promising, but abortive, Strathclyde system and specifically

(iv) to offer, in its 'set involvement analysis' an element of program for use prior to compilation, which appeared to provide an operational basis for the taking of decisions about the specific forms in which Brookes' principle of incompatibility had to be observed, coupled with a print-out facility for descriptions of lists of entities which could not, logically, be included together within the same timetable cycle.

These factors, together with an expression of interest by OSA Ltd. in the development of 'entity pooling' techniques within their system as a natural development from Lawrie's work and the relatively low price quoted for working with a small number of schools, led directly to the choice of the Oxford School Timetabling System as the vehicle for the present project.

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(5) We were not aware of any technical advantages offered by the SPL system over NORDATA for our purposes.

CHOICE AND CLARIFICATION OF AIMS

The broad aims of research into curriculum and timetable strategies had been the subject of discussions between representatives of schools, the Avon LEA and the author prior to the decision to use the OSA system. Four broad aims had been agreed in outline and had formed the basis of initial discussions with OSA Ltd. In their final form these read:

a. To relax the 'iron grip' of timetable constraints upon curriculum planning by investigations into the adaptation and extension of a commercially available school timetabling system (OSA) to enable it to be used as a management tool for curriculum planning in advance of timetable compilation.

b. To provide an opportunity for a number of secondary schools to gain experience in the use of computer assistance both in curriculum planning and in timetable compilation.

c. To anticipate major changes in the problems facing those with responsibility for curriculum and timetable planning in the early nineteen-eighties and to indicate possible responses.(6)

d. To investigate the interaction between schools as clients and a computer software agency as consultants in evaluating the introduction of computer assistance with the planning of curricula and the compilation of timetables.

It was however already clear that it would take time to acquire the funds needed to mount a substantial research programme along these lines, if indeed they were available. There was also the distinct possibility that potential sponsors would want to await the outcome of the trials being organised by LAMSAC(7) in which relative value of the three commercially available systems (i.e. NORDATA, SPL and OSA) were to be assessed in three English secondary schools. It was against this background that the decision was taken to mount a preliminary project of more limited scope:

(i) To gain experience of the application of the OSA system.

(ii) To move towards the production of usable computer-organised timetables.

and (iii) To make a start on the use of the OSA system, in its present form, in its planning mode.

At this stage the two schools were chosen to participate in the preliminary project. At Wells the emphasis was to be upon aims (i) and (ii) whilst at Hengrove it would be upon aims (i) and (iii) with (ii) providing a bonus if a usable timetable was achieved.

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(6) In 1976 our list of 'major changes' had been headed by 'falling rolls' and '16-19' reorganisation. By the time this report came to be written (1978), possible changes associated with changing examination structures, notably N- and F-levels, and with the provision of a core curriculum had risen to a similar degree of prominence as possible major changes on the horizon.

(7) Local Authorities Management Services and Computer Committee. The Report on these trials is now available: LAMSAC (1978).

THE HENGROVE SCHOOL TIMETABLE

Hengrove is an 11-18 Comprehensive School having approximately 270 pupils in each of the first 5 year groups and 150 pupils in the 6th form. Principal contributors to curriculum design and timetabling (and also to this project) have been P.J. Bird, Headmaster, and B. Rogers, Second Master. Broadly, the curriculum is common and general for all pupils to the end of the third year, with core and multiple option choices in years four to seven. The resulting timetable adopts 'consistent blocking' in the first three years whilst the multiple options still work across 'faculty' teams as is usual for this type of curriculum (i.e. the option groups in the upper school are heterogeneous). The possibility of such a hybrid structure had first been demonstrated practically in the 1975/76 Hengrove timetable.

The manual construction of the timetable follows the setting of school objectives and detailed curriculum planning in December, January and February each year. Proposed curriculum block diagrams are prepared and approved by Heads of Departments. Views are also sought about the structure of the proposed time allocation (e.g. single or double periods, fixed points in the week which are required etc.) and some indication given as to whether these might be met. A simple draft timetable is then prepared showing nothing more than when each activity might take place during the 40 period 5-day cycle (i.e. an 'outline timetable' in the terms of Lawrie and Veitch, op cit). No explicit reference is made to staffing at this point (or to the allocation of rooms), although these factors must be in the mind of the timetabler. The draft is then issued to Heads of Departments who comment upon it in terms of potential staffing, distribution of other resources, and particularly of time allocation throughout the week. Subsequent drafts are undertaken to meet criticisms and although these are often restarted from scratch the best parts of previous drafts are retained. There may be structural or curricular degenerations at this stage. Upon completion of the most satisfactory draft Heads of Departments are asked to allocate staff to this. Rooms are subsequently allocated and the detailed timetable completed.

USE OF THE OSA SYSTEM AT HENGROVE

Hengrove was particularly anxious to use the OSA package at an early stage in planning for the preparation of a draft timetable from the planned curriculum. Before commencement of the project it was hoped to produce a draft timetable from the designed curriculum and to modify this into subsequent drafts using the unique OSA 'interchange' algorithm (Dempster et al., (1975), op. cit.) and then selecting the best draft for compilation into a complete timetable either on the computer or manually.

Curriculum design was complete at Hengrove by the second week in January 1977. During the next three weeks some five hours were spent jointly by the Headmaster and Second Master planning strategy for presenting data to the computer. Rooms were not to be included since these were always a late addition and not included in the draft timetables. Over-use of practical rooms at any one time was avoided by careful teacher specification, this being done in disjoint groups or teams (Brookes, 1975) rather than individually, to retain the 'consistent blocking' concept. However OSA had not yet developed

'entity pooling' techniques.[8] (Teachers, rooms, resources are all entities which can be gathered into groups or pools where each individual might either be specific, or be part of a general number of entities declared. For example "nine maths teachers available" limits the number of maths lessons which can take place to nine without specifying which classes each of the nine teachers shall teach). In consequence each teacher was specified as a job code, some according to subject specialisation and others according to customary room use. This also left some flexibility in the number of staff available since the final school staffing was not known at that time. Decisions were also taken on methods of coding somewhat complex curricular structures in the third and sixth forms.

During the Spring half-term holiday the Head and Second Master met to encode the data on OSA sheets. In the event this took less time than expected, probably because of the careful preparatory work which had been done in advance. There were only nine data sheets proper in addition to the five preliminary declaration sheets and the task was completed in about 7 hours. After a final check these were sent to OSA on 23rd February. Almost 1 month passed before further work could be undertaken. The data validation had thrown up some inconsistencies (e.g. Teachers being required for 44 periods in a 40 period week, and similar over-loadings). Some errors could be dealt with by telephone, but others had to await the arrival of the printout by post. This did not arrive until 28th March but was dealt with and checked the same day. The data was finally cleared on 6th April and then submitted to the 'set involvement routine' of the OSA package.

A demonstration of the absence of set-involvements which require more teaching periods than there are available does not constitute a sufficient condition for timetable compilation (particularly because multiple periods and other considerations of distribution of entities over the cycle are not taken into account). However, the output from the analysis does list all the links between entities involved in oversized set-involvements. Thus it refers the decision as to which links to break back to the school. By examining these lists and re-arranging the entities involved so as to break some of the links the inconsistencies can usually be resolved. However, the time delay involved when printouts had to be sent through the post caused the whole process to become grossly extended. It was particularly frustrating since the number of inconsistencies thrown up proved larger than expected, and at least two proved 'cyclical' (i.e. changes made to resolve one problem caused others elsewhere). The whole process could undoubtedly have been made shorter by more immediate access to the computer.

So great was the delay, in fact, that the final date for preparation of a draft timetable had passed before the data had satisfied the set involvement routine. During this time the experience and knowledge gained from the set involvement routine was found to be of considerable significance in the manual compilation of three successive manual

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(8) OSA has since reported that some limited developments have now been made in this direction. It is now possible to specify that the teacher for class x at time y shall be drawn from an entity pool z; but it is not yet possible to specify further that other meetings of the same class shall be taught by the same member of entity pool z.

drafts, the last of which was selected as the basis for the eventual detailed timetable. Although the requirements were ultimately amended to satisfy the set involvement routine, the timetable produced when the compilation sector of the system was applied on 1st July constructed a partial timetable only, with an insertion rate of 83%.(9)

ON-SITE ASSESSMENT (HENGROVE)

Two assessments were made in connection with the Project:

1. The computer output was translated into a similar style to the Hengrove draft timetable for comparison purposes. Due to the way that the History/Geography/RE blocks had been encoded for the first three years the insertions of some of these blocks were incomplete. They were completed fairly readily, however, by manual entity pooling. This gave a slightly higher insertion rate (84.6%) than that achieved by OSA. On the other hand the system had inserted some Music, Art, Drama and Technical blocks in impossible places in the third year due to a logic error in data coding.

   A brief examination showed that further insertions could have been made using greater flexibility of staffing than has been available in the original data (entity pooling). Whether this incomplete draft could have been brought to completion manually was a matter of conjecture since time was not available to attempt this exercise. It was interesting to note some striking resemblances between the final manual draft and the incomplete computer output, possibly due to timetabler exposure to the OSA output during the planning stage.

2. Examination of the final manual draft (available before 1st July) to establish how far it met the original data specifications (i.e. those presented to the computer) showed that a strikingly similar proportion of the original specifications had been met (87.7%) and that the timetable had been completed by:

   (i) the insertion of a further 7.7% of items in a slightly degenerated form, by reducing the number of sets provided without alteration of the curriculum provided. (i.e. the size of classes as taught was increased in some cases, without reduction of the list of subjects available.) These changes were regarded by the school as the removal of redundant over-specification,

   and (ii) the insertion of 4.6% of items with some structural variation. There were eleven instances of this of which eight involved the substitution of single periods for doubles or vice versa, one involved a

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(9) Great caution must be used in the use of insertion rates for evaluation of timetabling systems since definitions vary. In the present instance the failure to provide a particular teacher for a single class which is itself a member of a large option block would lead to the failure to insert the whole option block, i.e. anything up to 50 entities. The insertion rate is therefore as much an indicator of the complexity of the brief as it is of the effectiveness of the timetabling system.

change in staffing for two periods when a part-time teacher would not be available and the other two (which were linked) involved the non-acceptance of pre-assignments for teaching particular classes at a particular time of day. Again there was no degeneration of the subject specification of the curriculum to be provided and it is not unreasonable to speculate that a similar result might have been achieved by 'inching up' the timetable compiled by computer.

The aims of this Preliminary Project were therefore met. The system was used at an early planning stage, and valuable experience was gained in the application of the OSA system which would lead to much more effective use of that system in subsequent attempts. In particular, new strategies and techniques would have to be developed for the coding of 'staff teams' in the continuing absence of an appropriate entity pooling system. There was also a need identified to attempt a timetable run with some subject departments (coded in compatible teams) in isolation from the remainder of the timetable. The curriculum planners at Hengrove remain convinced that unavoidable 'labelling' of individual staff most probably contributed to the serious over-specification of the school's requirements thus leading to needless incompatibilities.(10) The development of entity pooling techniques was therefore seen as a continuing priority, which has now been partially met in the OSA system.

THE OSA SYSTEM AT WELLS BLUE SCHOOL

In the case of the Blue School at Wells(11), an 8-form entry mixed comprehensive school with 1,330 pupils, the aims of the project were focussed on timetable compilation rather than on the development of a management tool for the planning phase. The principal problem here was more conventional than that at Hengrove. Quite simply, could the computer be used to produce the timetable more efficiently, freeing the timetabler for other duties, and could it be used to make wider-ranging searches for feasible alternatives so that curriculum initiatives did not have to be rejected on grounds of spurious impracticality?

The first task was to see whether a timetable could be constructed at all for a school with a ten day, fifty period cycle. In principle this did not present any particular difficulty to the Oxford system, which was not limited either to 5 days or to 40 periods in one cycle; data preparation and coding was begun in February 1977, but difficulties were encountered at once. These were due partly to difficulties of familiarisation - both of the school with the handbook supplied by OSA and of OSA with the complexities of the school's setting requirements for the upper forms. It is notable that instructions for "flexible option setting", in which schools were requested to indicate when individual setting requirements are interchangeable by colour coding on their 'allocation plans', did not appear in OSA's manuals until March 1977. It is also significant to note that the data submitted by the Blue School constituted an 'ideal' brief, featuring option blocking in

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(10) The word 'labelling' as used here has no pejorative overtones; it refers only to the fact that, without entity pooling, there was no facility within the OSA program by which the distribution of, say, four classes between two teachers could be left open without specifying which of the combinations AB/CD, AC/BD, AD/BC, CD/AB, BD/AC or BC/AD should be chosen.

(11) Headmaster, K. Bailey and Deputy Headmaster, with responsibility for curriculum and timetable, D. Fallows

the upper forms together with extensive setting (i.e. homogeneous blocking) in the lower forms, which had not been achieved by manual compilation. Thus 'success' in compiling a viable timetable would have been an unequivocal advance on present practice;conversely there was no opportunity to compare the performance of the computer system with that of the manual timetabler who was working on a different and more conventional brief.

It became increasingly evident, as work proceeded, that the telephone was both an inadequate and expensive instrument for the removal of difficulties; it was no substitute for face-to-face meetings in spite of the distance between Wells and Oxford. In spite of this, five distinct incompatible sets had been identified by OSA and resolved by the school by the end of June: these included conclusive demonstrations that certain desired option arrangements were infeasible, a finding which would have been most important - and timely - for a manual timetabler working to the same brief.

Finally, (by early July) the brief was cleared of incompatible sets and compilation runs were attempted on the upper school part of the timetable. These runs were, to the evident surprise of OSA, initially both long and abortive, a fact which led OSA to initiate its own enquiries into the reasons; one possible explanation is that the increased number of periods in the cycle (no cycle of more than 40 periods had previously been attempted) led to the examination by the computer of a much larger number of possible interchanges before 'sticking'.

ON-SITE ASSESSMENT (WELLS)

The timetabler at Wells had understandably mixed comments to offer. Pride of place in his comments was given to the observation (made at the end of June) that

> "to get the maximum effect it is important to be on line so that errors can be corrected immediately they arise. I feel that all that has happened between May 11 and the present time could have been done in under a fortnight had I been at the computer centre with G."

But the initially relatively disappointing outcome at Wells had not dulled his interest in the Project; he went on to identify three problems for immediate further investigation the following autumn (i.e. prior to the next timetabling cycle[12]; at least two of them would have involved radical structural change at the school:

> "(i) a four-year mirror[13] with options only in years 5, 6 and 7
> (ii) a faculty based curriculum
> and (iii) the effect our present second year bulge will have when it reaches year 4."

Finally, there was an understandable suggestion of satisfaction in

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(12) In fact a further problem claimed his attention when a banded structure was adopted on an interim basis, since this strategy shared with the mirror strategy (see below) the feature of reducing the number of teachers required in each staff pool for timetabling purposes.

(13) by which he meant a pattern in which each of the first four years would be divided into two equal halves, identical both in respect of ability and of curriculum requirements, (also social characteristics etc...), so that the numbers of teachers required simultaneously to teach one subject or group of subjects to a particular year group would be effectively halved.

his comment that:

> "I also suspect that our complexity has surprised OSA in that they had to extend their manuals to cope with the various problems thrown up..."

Was this practitioner beginning to believe that the schools might run the computer rather than vice versa?

The data were now 'dead' for purposes of timetable compilation for 1977-78, but the project at Wells was by no means over. At the end of July OSA forwarded a timetable for years three to seven to Wells, inviting comment. Although a 91% fill had now been achieved, it was immediately clear that some of the distributional features were unacceptable, e.g. where one class/teacher entity was allocated to two periods, out of five taught over the ten day cycle, on the same morning and when some periods were doubled in spite of requests to the contrary; this feature, if implemented without amendment, would have resulted in some elementary mathematics classes for older pupils lasting for two full hours and occurring infrequently - a teacher's nightmare! It was also observed that most of the unacceptable distributional features related to the fourth and fifth year timetables, where heterogeneous option blocks within which different subjects had different distribution requirements were to be found.

One month later, on 31st August, another draft was submitted, this time for years four to seven; this featured a 93% fill and, in the eyes of the school, a much better distribution of teaching periods over the ten day cycle. "If I had had that one on June 1st, I would have used it as the basis for the manual timetable"(14) was the most indicative comment made on this draft.

The next (and latest) draft was sent to Wells seven months later, when further funds had become available to permit a long computer run to be attempted, using data for the whole school, years 1-7. Work on detailed assessment of this timetable is still in hand at the time of writing. First impressions, which can be reported at this stage, range from the hard statistics that a 93.1% fill was achieved and that a long computer run (2 hours) had indeed been necessary to the timetabler's comment that

> "this would have been worth inching up, especially if the tactic employed had been one of sustaining the distributional requirements while creating split sets(15), with the splitting arrangements proposed by the school, in order to get the philosophy on to the timetable."

The 'philosophy' referred to is, of course, that embodied in the original 'ideal' brief which had asked for a 'mirror' structured timetable in the lower school, without banding by reference to ability, combined with a heterogeneous option block system for years four to seven - a 'hybrid' with some similarities to that attempted at Hengrove.

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(14) Among the necessary amendments there would have been the elimination of a feature apparently traceable to the data preparation phase in which the school had not specified the important point that an entity coded REMATH (i.e. R.E. for half a group and maths for half a group) could not be immediately followed for the same group by a similarly structured entity coded SCIMATH without generating double mathematics for half of the group.

(15) i.e. by arranging for the teaching of some groups in particular subjects to be shared between two teachers

In comparing the results achieved at the two schools it may be significant that whereas Hengrove, with a five day cycle of forty minute periods, found some deviation from idealised distribution patterns acceptable in the final 'inching up' phase of timetable compilation, at Wells, with a ten day (two week) cycle of sixty minute periods, these were far less easily accommodated; but split sets, provided that they were planned by the school, were not seen as intolerable. Can the compilation phase of the programme be arranged so as to indicate the choices between strategies open to the school in a manner similar to that in which the set involvement phase of the OSA programme is used to indicate which set involvements must be broken, without prescribing how this should be done? Here, certainly, is a question of high practical importance addressed to the developers of the system.

THE OSA PERSPECTIVE

The basis for this part of the enquiry was laid in an interview with OSA's Operations Manager, who had prime responsibility on the OSA side for OSA/school relationships. His background was that of a computer scientist with a little over two years' experience in the field, studying combinatorial problems; he had become particularly interested in consultancy work on scheduling problems in educational establishments. He had not taught in any school.

He offered three broad reasons for OSA's interest, the search by a business for markets with growth potential, a desire - especially on the part of OSA's managing director (Dempster) - to find 'useful' applications for university research findings and the search for intellectual satisfaction in solving complex problems. To these he added his own personal emphasis, as a computer scientist, on the need to make OSA's package usable by school timetablers[16]; he appeared to feel that technical solutions to timetabling problems might be running ahead of the managerial understanding which would be needed for their implementation. Indeed, he claimed that the most significant of the difficulties anticipated by OSA was the rejection of computer assistance by schools under the perceived threat of loss of flexibility and autonomy.

> "We hold they don't lose control, but we have to convince them. We have to help the interface man to swing it with his colleagues; we often don't meet them ourselves."

When questions were asked about unanticipated difficulties, the response was at two levels. Detailed examples which had been difficult to build into the system were cited, e.g. one school had requested double periods for French with half the time spent in the language laboratory. But one major proposition also emerged, that on-the-job experience assists OSA in formulating the users' objectives (and refinements) rather than in solving major technical problems; in

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(16) A point which was subsequently reinforced at the close of the interview when, in response to the usual open question "Anything you wish to add?", the reply came "I would like to see a timetabler's perception of what a computer assisted timetable system should be doing.....not enough is known about the average timetabler and his needs."

this respect there was a penetrating observation that North American timetables were typically pupil/teacher timetables, that traditional British timetables were typically of the class/teacher variety, but that modern British practice was demanding hybrids of these two approaches for which algorithms were only now being developed. Most significantly for the context of the present project he reported OSA's

> "recently increasing recognition that in schools curriculum policy is expressed in entity pooled terms prior to construction of the timetabler's brief for compilation" -

an observation which is entirely congruent with developmental trends which are being assiduously encouraged by the COSMOS group of Her Majesty's Inspectors of Schools through their courses on Staffing and Management of Secondary Schools.

The next section of this interview was focussed upon the role of the 'analyst', i.e. the timetabler's opposite number within the computing agency. Here, it seemed, there was the greatest room for differences of opinion, not only between schools and computing agencies, but also between different computing agencies. The idealised role, as perceived within OSA Ltd., was that of identifying necessary decisions but not making them, within the real time allowed by the school's planning and timetabling cycle; other agencies were seen as placing less emphasis on this distinction (an assertion which necessarily remains unchecked) and schools generally were seen as being very sensitive to any suggestion that they were being 'led'. What then about the actual role? Was it ever actually necessary to take decisions which could or should have been taken in the schools? OSA had certainly attempted to 'generate suggestions' (i.e. to lead?) and had in other trials occasionally taken decisions to hurry things along after the data were dead in order to complete reports on their work. The implications of this comment appeared to be twofold:

(i) that schools would be more highly motivated to take decisions themselves when the necessity for them is presented in time for the outcomes to be of immediate practical consequence.

(ii) that schools might well regard external decision making as tantamount to invalidation of the attempt to produce a timetable.

Had OSA any answer to this problem which they had set themselves? Tentatively, yes. It was strongly emphasized that the role of analyst, or interface man, would pass increasingly to the school's timetabler himself as he gained experience in use of the system. The role of OSA's analysts would be increasingly restricted to the communication, in both directions, of developments.

What about the role and status of the timetabler in the school? Should he or she necessarily be a senior member of staff? On this point there was complete agreement between OSA and the two schools immediately involved. This was seen as a matter for the school to settle in the knowledge that commitment was usually even more important than competence as a manual timetabler. If a school requires its difficult compromises to be legitimated by a senior member of staff, then that member of staff must be in direct communication with OSA. The essential point is quick decision; the scarcest resource is real

time, which cannot be allowed to slip away as one communication delay piles upon another .... The congruence of this answer with that of the assistant head and timetabler at the Blue School who characterized himself as

> "the negotiator for the school with individual departments on time allocation and dispositions"

is complete.

Thus the main conclusions reported by participants were, by the schools:

(i) that the OSA system is a potentially valuable tool for curriculum planning purposes and that its value will be enhanced if an entity pooling system can be developed for coding staff teams without specifying individual members thereof,

(ii) that speed of interaction between school and computer agency is vital, if schools are to be able to exercise their own discretion to the full in responding to calls for modification of requirements when infeasibilities are found by the computer.

and, by OSA:

(iii) that "the problem of clearing inconsistencies in a set of timetabling or curriculum requirements has been brought into focus....it is by manipulating pools of entities that inconsistencies may be resolved,

and (iv) more speculatively, that "an examination of the practicalities of using computer systems for curriculum planning in the shortest possible time scale would probably give rise to a rigorous specification of the ideal planning system. This would in turn speed up the technical developments needed to produce such a system."

OVERVIEW

It would however be an over-simplification to leave the findings in this relatively bald form. Observations over time of the interactions between OSA Ltd., cast as the change agent system, the two participating schools, cast as user systems and the OSA School Timetabling system, itself seen as "the innovation" in the terms proposed by Bolam (1975) in proposing a conceptual framework for the management of educational change, suggest some further pointers to future development.

First, it is clear that all four systems have changed as a result of the interaction. OSA has a changed perception of school needs, its timetabling system has already been amended to accommodate flexible subject setting and both schools have a more fundamental understanding of their own curriculum planning problems than before - even though, for reasons of finance or otherwise, the OSA system has not yet been adopted for routine use in either school.

Secondly, the OSA plea for rigorously specified ideal planning

systems[17] may turn out to be of crucial significance in a period when schools, led by men and women with 30 years' experience of almost uninterrupted expansion of schools and school systems, face the changeover to an era of declining enrolments in which manpower is becoming ever more costly while the cost of computer hardware of a given capacity plummets. One may reasonably doubt whether many of these leaders have had the opportunity to gain experience or the expertise relevant to these new conditions. It could however be the case that these leaders could find great benefits in continuous interaction with "outsiders"[18] who have a shared interest in clarifying the objectives and strategies of curriculum planners. This is one way in which they can avoid falling behind in their understanding of the continuously evolving ideal planning systems to which they have to respond.

At the level of the practical and immediate, could a start be made by LEAs providing local computer capacity with interactive facilities to schools interested in developing their curriculum and timetable strategies on a workshop basis?[19] How much could schools learn from each other by joint participation in such an activity? Would they be able to transform their already skilled anticipation of difficulties into the capacity to make better constructive plans in response to them? Computers do not offer a panacea to timetablers - indeed they are perhaps unlikely, as at Wells, to find solutions within the bounds of 'real time' to problems which the schools do not know, in principle, how to solve for themselves. But the activity of using them does provide a learning context in which major problems can be reviewed, clarified and solved in a manner which is communicable to others able to recognise significant similarities in their own situations. Individual schools should have this kind of opportunity to learn from one another at the strategy planning level while retaining their operational autonomy. It may be some years before specialist computer agencies become large enough to have the economic resources to update their systems with sufficient rapidity to keep up with the changing strategic needs of the schools. But, ironically, they may well have a crucial part to play as consultants

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(17) In the months which passed between the interview with OSA's Operations Manager, already summarized, and the preparation of this report, there has been an important shift from the earlier speculative plea for "rigorous specification of the (singular) ideal planning system" to a recognition by OSA that "we are now aware of many more ways of using the system." This awareness was coupled with a challenge to schools as potential users: "In devising flexible strategies, users in the early days of development will have to be adventurous - they must be flexible in their attitudes to using the system and willing to try anything technically feasible." (OSA's Operations Manager, July 1978, in commenting upon an earlier draft of this Report).

(18) i.e. "outsiders" to the education system. There are already many "outsiders" to individual schools, notably advisers and inspectors, who perform a similar role within the education system.

(19) Both the NORDATA and SPL systems are currently available for leasing to Local Education Authorities. The OSA system can be leased similarly or, especially if it is required on an individual school basis, access is available to the program installed on the Open University's computer, provided that the user has access to a suitable terminal.

or change agents in helping schools to render the current generation of computer programs with their associated strategies obsolescent. Indeed, it is probably flexible strategy scheduling which is needed. Two 'dimensions' of this flexibility have been seen to be of immediate significance. One, which was anticipated in planning the research, refers to strategies for entity pooling, especially with respect to the composition of teacher teams; the other, which was not foreseen at the outset, refers to the schools' need to make their own informed choices between alternative strategies for 'inching up' in the final stages of timetable compilation. When these features are fully available, computer assisted curriculum planning may well become the norm rather than the exception in this country. Those involved in the small project reported here believe they may have seen some of the first steps in that direction.

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